

ARCHITECTURE'S IMPACT ON ENGINEERING

Recent trends in architecture have implications for the use of steel in the design of buildings

By Peter J. Trebilcock



IN RECENT YEARS, DESIGNERS HAVE GRASPED THE MANY CHANGES IN TECHNOLOGY—changes that have opened up a myriad range of new design possibilities. These new options are partly the result of the interrelationship of theories of statics, dynamics and pure mathematics and partly because of the development of new materials such as strong adhesive, silicone jointing for glass assemblies and ductile iron. The result, though, is a change in both the way buildings look—and how steel is used in their design.

At best, this approach involves the creative fusion between the science of structure, services, materials and ecology with a wider variety of expressions than have been available previously. At worst, however, this approach has been criticized as technology fetishism and discarded by some as trivial expressions of high technology. However, many architects believe that by comprehending what wonderful opportunities contemporary engineering affords, they can genuinely improve the environment in which we live and work.

The honest expression of form is not a new trend in architecture. It has been present in almost all periods and design theories. While the ways in which forms are sculpted vary enormously, steel has demonstrated its ability to provide the designer with a material that

has a wide degree of flexibility in scale and texture, and can be executed with sophistication or simplicity, in modest form or spectacular, or in a lightweight or in a lightweight or robust manner.

ENVIRONMENTAL CONSIDERATIONS

Another major trend influencing architecture is increased environmental awareness.

The Habitat conferences and the Rio Earth Summit have focused international awareness among architects on this issue—and there is no question that architecture can influence energy consumption in the built environment.

The work of architects who aim to build with ecology and the environment in mind tend to fall into two camps. In one camp are those who use earth or organic forms. They see traditional and vernacular methods and materials as the panacea for all environmental ills. The resultant buildings are characterized by their autonomous services, turf roofs, electrical generation capacity, rainwater recycling, composting toilets, or unique structures such as mud covering old tires and other discarded materials. While praiseworthy in principal, they cannot often be called architecture.

The other camp – the ‘High-Techs’ are also contributing to the protection of the environment. They use modern technology and materials available to them in such a way as to minimize the strain on the earth. True green design is more than a technological add-on. Of course there are the architects who straddle both camps. They employ the imagery of the first, while using the technology of the second. Green architecture, by emphasizing its stylistic expression, may always be consigned to the fringe. More often than not, so called environmentally friendly products and techniques produce designs of little or no architectural merit. One example of a



Above is the Queens Building, De Montfort University, in England. Photo by Peter Cook and Lens Based Media.

structure that shows that green need not equate to bad design is the Ionica Building at Cambridge, England. It combines the structural advantages of a slim floor with both passive and active environmental techniques to achieve a low energy solution. Another far-from-dull solution is the award-winning Queens Building at Leicester University by Short Ford Associates. This combines a rich mix of materials from steel, brick, shingles and ceramics in a fusion of drama, incorporating thermal chimneys, thermal mass and passive ventilation flows.

In his book “Bioclimatic Skyscrapers”, Ken Yeang acknowledges the low energy possibilities offered on orientation, location, as well as aspects such as glazing, planting, open terraces and shading elements as integral elements of his multi-story forms. The Inland Revenue Headquarters in Scotland proved that low energy building design features within a steel framed building can be procured economically. There are those who argue that architecture which employs high technology is not environmentally friendly. Such

buildings, they claim, can not be sustainable no matter how little energy the final building consumes, because such saving are more than offset by the energy used to make the building and its components. Some other architects, such as Joachim Eble in his Prisma Building for Karlsruhe Life Insurance in Nurnberg, Germany, take the view that concrete is no better. They see concrete as an important contributor to global warming through carbon dioxide released in manufacture. In response, he substituted concrete floors with hollow brick pots.

One solution, which demonstrated several years ago that an energy balance could be achieved, was the UK pavilion at Expo '92, in Seville, Spain. Designed by Nicholas Grimshaw and Partners, it was one of the few pavilions to fully develop the Expo's themes of discovery and technological innovation. The architect proved that ecological concerns and high tech architecture are not mutually exclusive. They utilized solar power through roof mounted solar power panels to power the water pumps which created a giant



The Berlin Stock Exchange in Berlin, Germany. Photo by Jens Willebrand.

water wall, which cooled the large amount of feature glazing to the main east elevation. On the west façade, the side most vulnerable to overheating, he devised his own version of the thermal mass using shipping containers filled with water. It would be naïve to assume that the wholesale embrace of the ecological agenda would not affect architectural expression although whether the elements of energy control and sustainable material selection are overtly expressed remains the decision of the designer.

Designs of office workplaces are responding to users' more demanding requirements of fresh air supply, closer proximity to windows, in buildings which are cheaper to run and easier to maintain. In many cases, these short span, low technology solu-

tions utilize a concrete structure which is left exposed using its thermal capacity to assist cooling requirements. Large areas of operable windows maximize daylight with external solar shading and internal blinds controlling solar gain and glare. Some former noted specifiers of steel appear to have switched their allegiance to concrete framed solutions. While the switch to concrete is not universal, it can often relegate the use of steel to a thin cosmetic veneer without structural substance, or as an interior design element such as a bridge, applied within a heavy-weight frame.

Two buildings that illustrate the stylistic, technical and philosophical differences in design between Europe and the U.S. are the Daimler Benz Offices in Berlin and Commerce Place in

Baltimore, MD. The Berlin offices for Daimler Benz have operable windows, partially exposed ceiling slabs to optimize natural ventilation and nocturnal cooling, and expressed articulate elevational forms. The U.S. equivalent has sealed windows with full air conditioning (albeit CFC free), conventional suspended ceilings with carefully designed lighting having a low flicker rate, and sophisticated building management systems which reduce energy usage. The elevations remain traditional corporate downtown USA.

While the idea of using a structure's thermal capacity is not new, some designers perceive that the greater the mass, the better the solution. In many instances, this has been the result of misinformation, especially pertaining to issues such



The Millennium Experience at Greenwich, in London, England. Photot taken by Grant Smith.

as thermal capacity. However, tests have demonstrated that heavy mass structures are not necessary for high levels of thermal capacity and research has demonstrated that lightweight steel solutions can perform as well as the heavyweight alternatives.

One example in steel, which demonstrates a positive response to this trend, is the Kimberlin Library Extension at De Montfort University, in Leicester, England. Designed by Eva Jiricna Architects, this building incorporates both passive and active features. The width of the building maximizes the use of daylight via both translucent and clear glass, permitting views out while controlling solar gain. The steel framed building with a regular grid allowed for fast and economic erection. A mechanical fresh air system was selected in association with pre-cast concrete floor planks as distribution, utilizing the mass of the structure for passive cooling.

The system, Thermodek, is used extensively in Scandinavia, and can produce high fresh air input associated with air movement without the need for a chiller plant.

Another seminal building is the Commerzbank Headquarters in Frankfurt. This multi-story building breaks all the rules for this building type. It will be naturally ventilated for 9 months of the year and stands at the forefront of environmentally responsible modern architecture. After undertaking a value engineering exercise with the engineers at Ove Arup and Partners, steel was selected in preference to a concrete frame because it was less expensive, lighter and its slender columns maximized the usable floor area.

COMMERCIAL CONSIDERATIONS

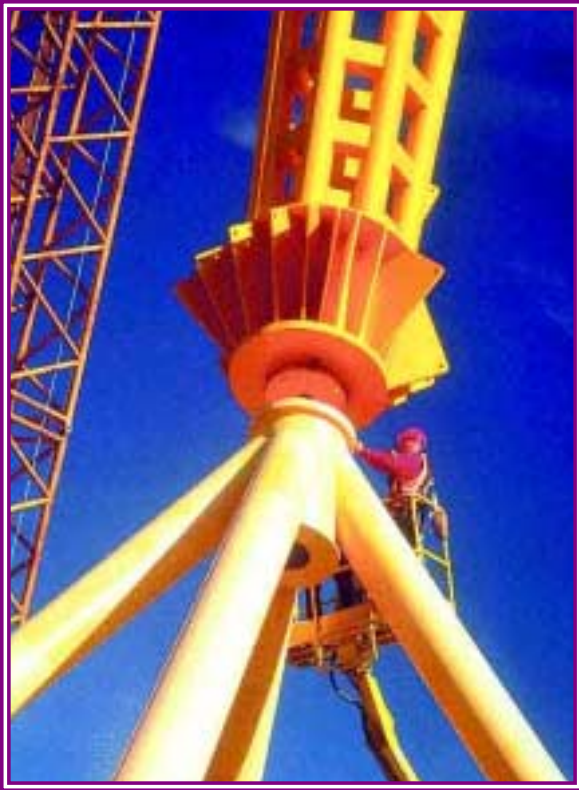
All design professionals recognize their influence is contingent on the self-interested forces of politics and business, and the motivation of individuals to adopt appropriate changes in attitudes. Two supermarket chains in the U.S. have developed prototypes for environmentally conscious stores. Some Wal-Marts feature glulam beams, timber frames and plywood. It has been dubbed Eco-Mart! Designers of another chain, Best supermarkets, locate their stores in densely wooded suburban areas, so as not to destroy the existing vegetation. The sur-

rounding forest invades the structure in such a way that architecture appears consumed by some role reversal ... nature's revenge.

Despite the fact that the environment is an important issue for most people, the majority of clients do not have an ideological commitment to improving the environment in the broadest sense if they require increased expenditure. They are, presently, unwilling to make the necessary increased capital investment.

The ING Bank Budapest in Hungary utilizes a traditional method of procuring buildings. Designer Erick van Egerat created the building as a strong statement for his client. The design was fully complete prior to tendering and construction. This method exerts little influence on designers who choose the materials and systems on their personal and client preferences, as well as cost factors. However, other methods of procurement are gaining popularity because of pressures to save construction and 'lead-in' times or because the expertise of a contractor may be deemed beneficial at an early stage. (Non-conventional contracts now account for more than 50% of all contracts in the UK.) Each method influences the timing of design decisions, the selection of materials and systems as well as increase or decrease the degree of client risk or cost uncertainty. The correct choice of procurement route is critical to the successful realization of these objectives.

The Berlin Potsdammer Platz was a fast track development, yet the designers still managed to achieve design excellence with technical innovation, in which steel played its part. There is growing evidence that 'partnering' between client, designer and contractor, rather than the traditional and often adversarial approach, provides practical solutions – and innovative ideas that achieve cost certainty and can still maintain the quality of design. Thus it satisfies clients,



architects, engineers and producers alike. AMEC Design and Management are pursuing this approach for the International Soccer Hall of Fame to be based in Manchester, England, which is in its early design stages. Such partnering schemes have included the steelwork elements of the Scottish Exhibition Centre nicknamed the 'Armadillo', with Norman Foster. This effort achieved the required design quality yet saved money, proving that the saving of capital expenditure is also a significant influence on contemporary design trends.

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